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Sulphur/mechanochemical graphene/bismuth phosphate composite as a cathode for enhanced performance in lithium-sulphur batteries

Abstract

A lithium-sulphur battery is fabricated by incorporating graphene and bismuth phosphate ($BiPO_4$) into the cathode. $BiPO_4$ is synthesized via a hydrothermal method, while graphene is prepared through a mechanochemical process. A sulphur/mechanochemical graphene/bismuth phosphate composite is then prepared and analyzed using various characterization techniques. Functional groups are identified through FTIR analysis, and the crystal structure and chemical composition are examined using X-ray diffraction. Scanning electron microscopy is employed to explore the size distribution and surface morphology of the composite. The electrochemical behaviour of the cathode material is characterized using electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV), and galvanostatic charge/discharge (GCD) techniques. The CV measurements confirm a high specific capacitance of 476.78 F/g at a scan rate of 10 mV/s for the composite. The cathode material retains 99.52% of its capacitance at 1 A/g even after 1,500 cycles, demonstrating long-term stability. A well-performing S/MCG-Bi(PO4)-800 cathode was used to construct the coin cell. The CR2032 coin cell with S/MCG-Bi(PO4)-800 as the cathode demonstrates a specific capacity of 61 mAh/g during charging and 47 mAh/g during discharging. However, by the 50th cycle, the capacity retention decreases to 60.78%. Additionally, the coulombic efficiency at constant current is measured at 80.02%.

Keywords

Bismuth phosphate; Charge/discharge; Energy storage; Graphene; Lithium-sulphur battery